

In re Patent Application of:
RAYNOR ET AL.
Serial No. 10/677,850
Filing Date: OCTOBER 2, 2003

REMARKS

Applicants would like to thank the Examiner for the thorough examination of the present application. The independent claims have been amended to recite that the landings are on the mounting substrate adjacent the opening therethrough and are provided with the bump bonds, as supported by paragraph 13 in the Applicants' specification. The Applicants submit that the claims are definite. The claim amendments and arguments supporting patentability of the claims are provided below.

I. The Amended Claims

The present invention, as recited in amended independent Claim 39, for example, is directed to method of attaching a sensor and a housing to opposite sides of a mounting substrate. The sensor has a sensing face and comprises a sensing area and at least one signal output contact thereon. The mounting substrate has a circuitry face and at least one signal input contact thereon. The mounting substrate also has an opening therethrough and at least one landing adjacent the opening. The method comprising positioning the sensing area over the opening so that the at least one signal output contact of the sensor contacts the at least one signal input contact of the mounting substrate.

The sensor is attached to the mounting substrate via at least one bump bond interposed between the at least one signal output contact of the sensor and the at least one signal input contact of the mounting substrate to pass signals therethrough, with the at least one bump bond being associated with the at

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least one landing so that the at least one bump bond is aligned with the at least one signal output contact of the sensor. The housing is positioned in contact with the mounting substrate so that the housing and the sensor are in alignment.

Independent Claim 57 has been amended similar to amended independent Claim 39, but does not recite the housing.

II. The Claims Are Patentable

The Examiner rejected independent Claims 39 and 57 over the Venkat et al. patent in view of the Bauer et al. patent and in further view of the Casson et al. patent. The Venkat et al. patent discloses an integrated lens and aperture plate for an optical sensor equipped integrated chip in which the lens and the aperture plate are molded as one piece with the lens at the appropriate location so that the lens aligns with the location of the optical sensor. In particular, FIG. 2 in the Venkat et al. patent illustrates a sensor 32 being attached to a mounting substrate 36. The sensor 32 is attached via the pins extending therefrom by inserting the pins through the openings in the mounting substrate 36.

As correctly noted by the Examiner, Venkat et al. fails to disclose the use of bump bonding for attaching the sensor to the mounting substrate. The Examiner cited the Bauer et al. patent, and in particular FIG. 2 therein, as disclosing the use of bump bonding using solder bump 120 in attaching an optical sensor 22 to a mounting base substrate 28 that comprises circuitry (e.g., conductive strip 30).

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Serial No. 10/677,850
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In addition, the Examiner cited Casson et al. as disclosing the attachment of a chip device to a flexible printed circuit board using solder bumps to facilitate a secure electrical connection. The Examiner referenced column 16, lines 52-68 as disclosing self-alignment of the chip device to the mounting substrate comprising a flexible printed circuit board using a solder bump bonding methodology that also comprises a heating step.

The Examiner has taken the position that the use of bump bonding in the assembly of integrated circuit and printed circuit board devices is well known in the art, thus making it obvious to a person of ordinary skill in the art to use bump bonding in the assembly of the claimed invention.

The Applicants respectfully disagree. While bump bonding is more commonplace today, the bump bonds in Bauer et al. are attached to a long conductive strip 30 which extends from near the aperture 122 outwards to the edge of the base substrate 28, as shown in FIG. 8. The same conductive strip is used in all embodiments. It is also clear from FIG. 1 in Bauer et al. that the conductive strip is relatively wide. Bauer et al. is silent regarding the issue of alignment. In many of the embodiments, conventional wire contacts 32 are used in Bauer et al. for aligning the optical sensor 22 with the substrate 28.

In Casson et al., the illustrated flip chip 10 fails to disclose a mounting substrate having an opening therethrough as in the claimed invention. Reference is directed to column 7, lines 7-21 of Casson et al., which provides:

In re Patent Application of:
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Serial No. 10/677,850
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"Referring to FIGS. 1a and 1b, a flip chip is an unpackaged silicon integrated circuit chip, such as flip chip 10, having a silicon chip 17 containing the integrated circuit components and coated with an active side passivation layer 11a on the active side 12 to protect its components from environmental contaminants. It has markings 13 applied to its back side 14 for identification purposes, and a back side passivation layer 11b coated on back side 14 to protect the markings. It also has a number of aluminum/copper bonding pads, such as bonding pad 15, which are located at various positions on the flip chip's active side for making electrical connections with a substrate. Solder bumps, such as solder bump 16, are further attached to these bonding pads." (Emphasis added).

As best illustrated in FIGS. 1a and 1b and as stated above, Casson et al. teaches away from an opening in a mounting substrate associated with the flip chip 10 because of reflow of the soldering between the bonding pads 15 and the solder bumps 16 for providing the electrical connection.

As correctly noted by the Examiner in column 16, lines 52-68 of Casson et al., a solder composition is formed by reflowing solder paste located on the corresponding active contact pad on the circuit board such that a solder bump located on the corresponding bonding pad on the flip chip is allowed to self-align with the corresponding active contact pad and such that the solder paste mixes with the solder bump, and wherein each electrical connection is formed concurrently by applying

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heat to the circuit board and flip chips as a whole after the flip chips have been placed on the circuit board in a manner which allows for unobstructed motion of the flip chips during reflow.

If there was an opening in the mounting substrate associated with the flip chip 10 in Casson et al. as in the claimed invention, then the soldering between the bonding pads 15 and solder bumps 17 would not be able to reflow as necessary for providing the desired electrical connection. As noted above, each electrical connection in Casson et al. is formed concurrently by applying heat to the circuit board and to the flip chips 10 as a whole after the flip chips have been placed on the circuit board in a manner which allows for unobstructed motion of the flip chips during reflow.

The Applicants submit that one skilled in the art would infer upon reading Venkat et al. that the wire bonds, together with their corresponding apertures, would not be necessary for ensuring an accurate alignment of the IC with the PCB. Venkat et al. is concerned with alignment of the sensor and the lens, and the approach taught is to integrate the lens with an aperture plate that also receives the IC 32. In Venkat et al., conventional wire contacts are used for aligning the optical sensor IC 32 with the substrate. The whole sensor/aperture plate/lens is attached to one side of the substrate. Therefore, Venkat et al. is not concerned with the precise alignment of the sensor and substrate.

In Bauer et al., since the conductive strip used to

In re Patent Application of:
RAYNOR ET AL.
Serial No. 10/677,850
Filing Date: OCTOBER 2, 2003

attach to the bump bonds is relatively wide, Bauer is silent regarding the issue of alignment. Moreover, in many of the illustrated embodiments, conventional wire contacts 32 are used for aligning the optical sensor 22 with the substrate 28.

In Casson et al., self-alignment of the solder bump with the flip chip is based on the solder paste mixing with the solder bumps during the heating. This requires an unobstructed motion of the flip chip during reflow - and inclusion of an opening in the mounting substrate adjacent the flip chip would impede the reflow of the solder paste.

It thus appears that the Examiner is using impermissible hindsight reconstruction to modify the Venkat et al. patent in view of the Bauer et al. patent and in further view of the Casson et al. patent. The prior art references, individually or in combination, do not teach or suggest a mounting substrate also having an opening therethrough and at least one landing adjacent the opening, and attaching the sensor to the mounting substrate via at least one bump bond interposed between the at least one signal output contact of the sensor and the at least one signal input contact of the mounting substrate to pass signals therethrough, with the at least one bump bond being associated with the at least one landing so that the at least one bump bond is aligned with the at least one signal output contact of the sensor.

Independent Claim 39 recites that the at least one bump bond is associated with the at least one landing so that the at least one bump bond is aligned with the at least one signal output contact of the sensor. The at least one landing and bump

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Serial No. 10/677,850
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bond are provided as spots at specific locations. This specific arrangement of spot lands and bump bonds may provide an advantageous effect of improving the alignment of the image sensor with the mounting substrate. The bump bonds may be heated to melt the solder to make an electrical connection between the signal output contacts of the image sensor 14 and the PCB lands 18, as shown in FIG. 1 associated with the Applicants' specification. As the spot bump bonds melt they try to minimize forces in their surface tension and thus deform evenly. There is thus a net effect of this action to draw the image sensor into a precise alignment with the aperture.

The bump bonds and landings adjacent the opening in the mounting substrate in the claimed invention thus provide an advantageous effect of actually improving the alignment of the sensor with the mounting substrate. This is not intuitively the case, as movement caused by the melting of the bump bonds would have normally been considered by one skilled in the art at the time of the invention to introduce a further inaccuracy or source of error in the alignment. However, the Applicants have found that counter to these expectations, the bump bonds actually help with the alignment.

Accordingly, it is submitted that amended independent Claim 39 is patentable over the Venkat et al. patent in view of the Bauer et al. patent and in further view of the Casson et al. patent. Amended independent Claim 57 is similar to amended independent Claim 39. Therefore, it is submitted that this claim is also patentable over the Venkat et al. patent in view of the Bauer et al. patent and in further view of the Casson et al.

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patent.

In view of the patentability of amended independent Claims 39 and 57, it is submitted that the dependent claims, which include yet further distinguishing features of the invention are also patentable. These dependent claims need no further discussion herein.

IV. CONCLUSION

In view of the amendments to the claims and the arguments provided herein, it is submitted that all the claims are patentable. Accordingly, a Notice of Allowance is requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

Respectfully submitted,


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